

Application Serial No. 10/625,483
Attorney's Docket No.:14580-020001

REMARKS

Reconsideration and allowance of the above referenced application are respectfully requested.

Claims 1, 6 and 7 stand rejected under 35 USC 102 as allegedly being anticipated by Chen. Claims 2-5 and 8-10 are rejected under 35 USC 103 over combinations of prior art. In response, claim 1 is amended to further distinguish over the cited prior art. In addition, new claims are provided, each of which are completely patentable over the cited prior art.

An embodiment of this application describes a method of forming a contact in a region of a device having a barrier layer. The method includes providing a contact hole barrier layer on the sides of a contact hole to prevent lateral diffusion resulting from the application of a wet etching treatment to the contact hole (see page 2, lines 8-19 and page 4, lines 14 and 15 of the present specification).

The rejection alleges that claims 1, 6 and 7 are anticipated by US Publication No. 2003/0087520 ("Chen").

With reference to Figures 2 to 5, Chen describes depositing a CVD barrier layer 30 (i.e. contact hole barrier layer) over the sidewalls and bottom of a contact hole 18, and on top of a dielectric layer 16 (see paragraph [0031] of Chen). A bottom portion 32 and a field portion 36 of the barrier layer 30 are

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then removed by sputtering (see paragraph [0036] of Chen).
Thereafter, a PVD barrier layer 40 is sputter deposited over the top of the dielectric layer 16, over the CVD barrier layer 30 on the sidewalls of the contact hole 18 and at the bottom of the contact hole 18 (see paragraph [0037] of Chen). Following which, a thin copper seed layer 44 is deposited over the PVD barrier layer 40 before the contact hole 18 is filled and overfilled with a copper layer 46 (see paragraph [0040] of Chen).

In order to further emphasize the distinctions over the cited prior art, Independent claim 1 has been amended to recite the additional features of a contact hole formed through a first barrier layer, and a contact hole barrier layer being continuous between the sides and bottom surface of the contact hole to further distinguish claim 1 from Chen. Support for the amendments to claim 1 can be found on page 4, lines 19-21, page 8, line 27 to page 9, line 2, Figure 4, and page 9, lines 9-11 of the specification.

Chen does not teach or suggest the formation of a contact hole through a barrier layer in a semiconductor device, the contact hole having sides extending above and below the barrier layer. Moreover, Chen does not teach a contact liner as it is now defined. The second barrier layer is only a barrier layer

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with no indication of being of use as a contact liner to promote subsequent filling. Moreover, the seed layer 44 is only a seed layer to effect filling. The skilled person would recognize that this is not a contact liner. Therefore, claim 1 as amended is not anticipated by Chen.

Claim 2 is rejected as being obvious in view of Chen and US Publication No. 2004/0102035 ("Lee"). The feature of the contact hole extending through a barrier layer, which is part of amended claim 1, was present in former claim 2. This contention is respectfully traversed.

With reference to Figures 3 to 6, Lee describes the formation of a contact hole 171' by etching a first insulation layer 160 and an upper barrier layer 150 (see paragraph [0029] of Lee). A lower barrier layer 205 is etched during a subsequent wet etch process, forming an undercut 173 (see paragraph [0030] of Lee). Thereafter, a second barrier metal layer 180 (i.e. contact hole barrier layer) is formed to cover a portion of the bottom and sidewalls of the contact hole 171, but not at the lower barrier layer 205 (i.e. first barrier layer) where the undercut 173 (i.e. void) is formed (see paragraph [0031] of Lee). The undercut 173 is subsequently filled with a second copper layer 190 when the contact hole 171 is filled and

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overfilled to form a contact plug 195 (see paragraph [0032] of Lee).

In Lee, the contact hole arguably does not have sides extending below the barrier layer, as well as a bottom surface. More particularly, the contact hole barrier layer is not formed continuously over the sides and bottom surface. It is completely lacking in the etched undercut and most of the bottom surface.

Moreover the combination of Chen and Lee would not make claim 1 obvious either. If Chen teaches the deposit of an additional barrier layer, then this would be applied to Lee by depositing a further discontinuous barrier layer on the first one 180 already deposited in Lee. The skilled person would not use Chen to learn to deposit a continuous second barrier layer in Lee because it would lead to gaps in the undercut, which would be unacceptable.

Claim 2

Amended claim 2 is limited to the features of wet etching the contact hole prior to forming the contact hole barrier layer, the contact hole barrier layer filling voids in the first barrier layer caused by the wet etching. Neither Chen nor Lee

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teaches or suggests the filling of voids in a barrier layer, caused by wet etching, with a contact hole barrier layer.

In particular, in the case of Chen, there are no voids in a barrier layer to fill and, in the case of Lee, it conspicuously fails to fill the voids that are formed (see Figure 5). On reading a combination of Chen and Lee, a skilled person would merely be led to deposit additional barrier metal layers, which will not fill the voids 173 in the first barrier layer 205 caused by wet etching, on top of the second barrier metal layer 180. Therefore, claim 2 is not obvious to the skilled person on reading a combination of Chen and Lee.

Claim 3

Claim 3 is rejected as being allegedly obvious in view of Chen and US Publication No. 2002/0098682 ("Kim"). This contention is respectfully traversed.

With reference to Figures 2A to 2E, Kim describes forming a contact hole in an insulation layer 3 (see paragraph [0027] of Kim). A barrier metal 5 (i.e. contact hole barrier layer) is formed on the insulation layer 3 (see paragraph [0028] of Kim). Thereafter, the contact hole is filled with an insulation layer 13 (see paragraph [0030] of Kim). A chemical mechanical polishing (CMP) process removes the top portions of the barrier

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metal 5, except the barrier metal 5 in the interior of the contact hole (see paragraph [0031] of Kim). Thereafter, a wet etch process is applied to selectively lift off the insulation layer 13 filling the interior of the contact hole, thereby exposing the barrier metals 5 on the sidewall and the bottom of the contact hole to the air (see paragraph [0032] of Kim). An Al layer 9 is then grown on the barrier metal 5 in the contact hole by a chemical vapour deposition (CVD) process (see paragraph [0033] of Kim). Following which, an Al layer 11 is formed by a physical vapour deposition (PVD) process to fill and overfill the contact hole (see paragraph [0034] of Kim).

Although Kim teaches the formation of a contact hole barrier layer 5 before the wet etching treatment, Kim is directed to controlling abnormal growth of the CVD-Al metal (see paragraph [0038] of Kim), Chen is directed to reducing the contact resistance at the bottom of a via (see paragraph [0011] of Chen), while the present application is directed to preventing lateral diffusion resulting from the application of a wet etching treatment to a contact hole. Moreover, Chen uses Cu to fill the contact hole. As such, processes useful in controlling abnormal growth of CVD-Al metal are irrelevant. Therefore, there is no motivation for a skilled person to combine the teachings of Chen and Kim, much less to solve the

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problem of the creation of diffusion paths arising from the application of a wet etching treatment to a contact hole, which the present application addresses. Accordingly, the invention claimed in claim 3 will not be obvious to a skilled person, on reading Chen and Kim in combination. The skilled person would not consider such a combination.

Claim 4

Pendency of claim 4 has been changed to depend from claim 3. Thus, the barrier layer is thickened after the wet etching step, which is applied after the first barrier layer.

Claim 11

New Claim 11 is directed to the first embodiment. In particular, it has the distinctive features of forming a contact hole through a portion of a device including through a first barrier layer, and forming a contact hole barrier layer to fill voids in the first barrier layer caused by wet etching.

It is novel over Chen and Lee because, as previously discussed, neither Chen nor Lee teaches or suggests either of these features. Moreover it is inventive over a combination of Chen and Lee for some of the reasons provided in the inventive

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step argument for claim 1 and some of those provided for claim 2.

Claim 12

New Claim 12 is directed to the second embodiment. In particular, it has the distinctive features of wet etching the contact hole after forming a contact hole barrier layer, and etching the contact hole barrier layer on the bottom surface of the contact hole.

It is novel over Chen because Chen does not teach or suggest wet etching the contact hole after forming a contact hole barrier layer. It is novel over Kim because Kim does not teach or suggest etching the contact hole barrier layer on the bottom surface of the contact hole. Moreover it is inventive over a combination of Chen and Kim for the reasons provided in the inventive step argument for claim 3.

In view of the above amendments and remarks, therefore, all of the claims should be in condition for allowance. A formal notice to that effect is respectfully solicited.

It is believed that all of the pending claims have been addressed in this paper. However, failure to address a specific rejection, issue or comment, does not signify agreement with or concession of that rejection, issue or comment. In addition,

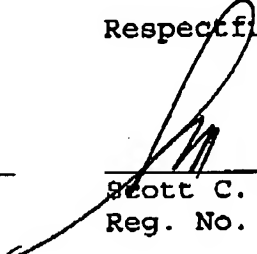
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because the arguments made above are not intended to be exhaustive, there may be reasons for patentability of any or all pending claims (or other claims) that have not been expressed. Finally, nothing in this paper should be construed as an intent to concede any issue with regard to any claim, except as specifically stated in this paper, and the amendment of any claim does not necessarily signify concession of unpatentability of the claim prior to its amendment.

Please apply any charges or credits to Deposit Account
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Respectfully submitted,

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